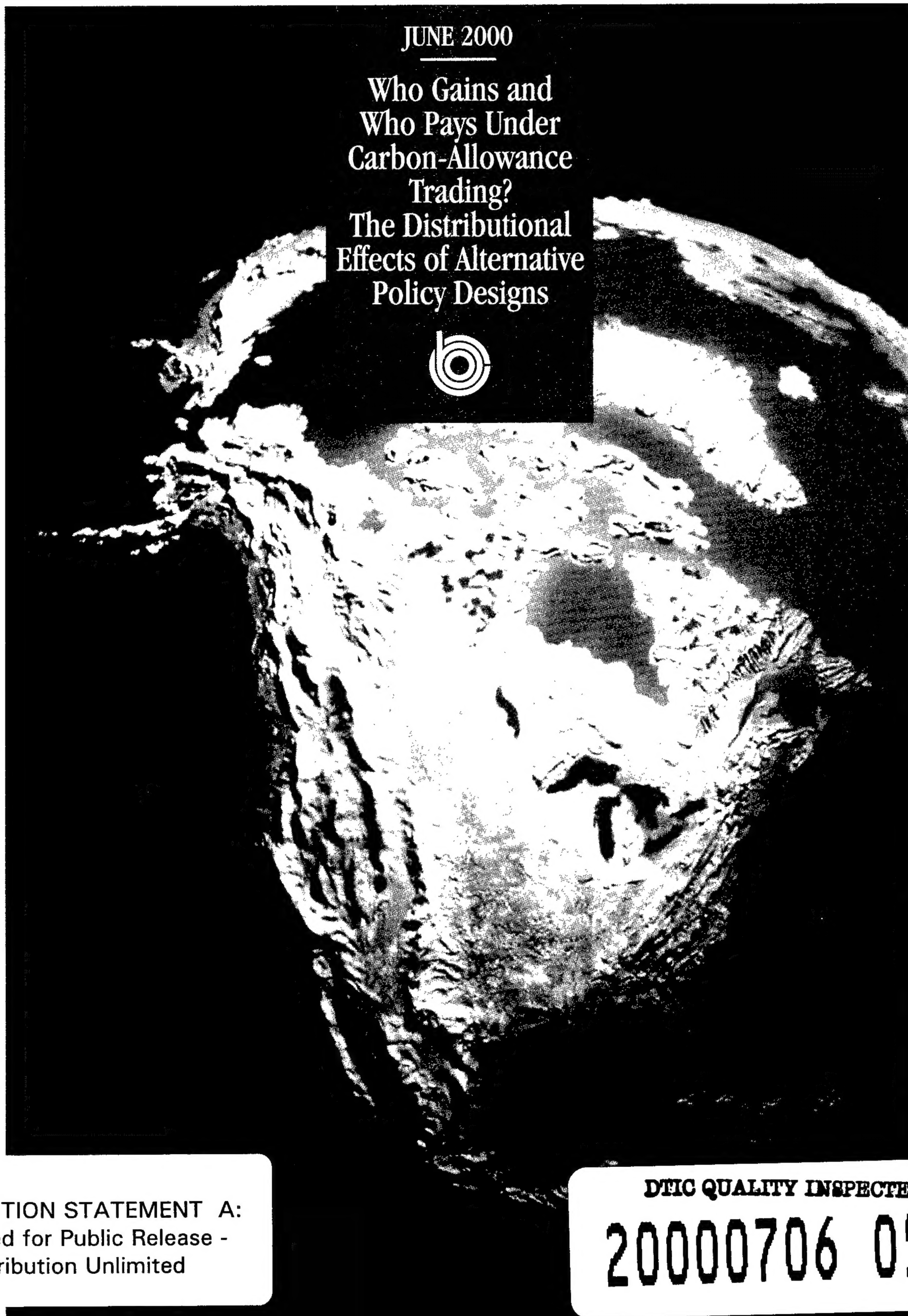
CONGRESS OF THE UNITED STATES
CONGRESSIONAL BUDGET OFFICE

A
CBO
STUDY

JUNE 2000

Who Gains and Who Pays Under Carbon-Allowance Trading? The Distributional Effects of Alternative Policy Designs



WHO GAINS AND WHO PAYS UNDER CARBON-ALLOWANCE TRADING? THE DISTRIBUTIONAL EFFECTS OF ALTERNATIVE POLICY DESIGNS

The Congress of the United States
Congressional Budget Office

NOTES

Numbers in the text and tables of this study may not add up to totals because of rounding.

Preface

Although scientists have long known that rising concentrations of carbon dioxide in the atmosphere affect the Earth's climate, considerable disagreement exists about what, if anything, should be done to reduce carbon emissions caused by human actions. One general area of agreement, however, is that if steps are taken to reduce emissions, they should achieve those reductions at the lowest possible cost. For that reason, policymakers and analysts have expressed interest in using economic incentives, such as a trading program for carbon-emission allowances.

This Congressional Budget Office (CBO) study examines how the potential costs of a carbon-allowance program would be distributed among U.S. households of different incomes. Those distributional effects could vary widely depending on the government's decisions about how to allocate the allowances and how to use any revenue that it received as a result of the policy. The analysis was done at the request of the Ranking Minority Member of the House Committee on Commerce.

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June 2000

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Summary

Scientists have known for more than a century that rising concentrations of carbon dioxide (CO_2) in the atmosphere affect the Earth's climate. Nevertheless, agreement on whether to reduce man-made CO_2 emissions—which are caused mainly by the combustion of fossil fuels—has been elusive because of uncertainty about the potential size and effects of climate change, the costs associated with lowering emissions, and the distribution of those costs. This study focuses on the last issue: how the costs of U.S. government policies to reduce CO_2 emissions (referred to here as carbon emissions) would ultimately be distributed among U.S. households.

If the government decided to curb carbon emissions, one cost-effective way to achieve that goal might be through an allowance-trading policy. Under such a policy, rather than mandating specific pollution limits for each source of carbon in the nation, the government could set an overall limit on emissions and require U.S. firms to hold rights (or allowances) to those emissions. Some analysts advocate an "upstream" program, in which producers and importers of fossil fuels would be required to hold allowances. Such a design would probably be easier to implement than a "downstream" program, in which the requirement was placed on the millions of users of fossil fuels. After an initial distribution, companies would be free to buy and sell allowances. Similar trading programs have been used for U.S. emissions of sulfur dioxide, which contributes to acid rain; for lead in leaded gasoline; and for various chemicals that are thought to deplete the ozone layer of the atmosphere.

The ultimate distributional effects of a trading program for carbon allowances would depend on two key decisions that the government would need to make in designing the program: how to allocate the allowances and how to use the additional revenue it received as a result.

Scenarios for Carbon-Allowance Trading

The government would have two primary methods of allocating carbon allowances:

- Selling them through an auction, or
- Giving them away (as past pollution-rights trading programs have done).

Either way, the government would receive at least some of the value of the allowances in the form of federal revenue. If it auctioned off allowances, it would receive their total value, which would equal the selling price multiplied by the number of allowances issued. If it gave allowances away, the fossil-fuel-producing or -importing companies that received them would have higher profits than would otherwise be the case. In that situation, the rise in profits would reflect the value of the allowances. The government would receive approximately 45 percent of that value through taxes on those profits (including state and local as well

as federal taxes). The other 55 percent of the allowances' value would ultimately benefit the U.S. households that were shareholders of those companies.

For this analysis, the Congressional Budget Office (CBO) assumes that the government would either give all of the allowances away or sell all of them through an auction. In reality, the government could use a combination of those methods. Likewise, it could allocate the allowances to users of fossil fuels rather than to producers and importers, as assumed here.

In addition to the method of allocation, the distributional effects of a carbon-allowance policy would hinge on how the government used the resulting revenue—what this study calls the "revenue-recycling" strategy. The government would need part of that revenue to cover higher costs that would result from the policy (such as the higher prices it would have to pay for energy and other goods). The remaining share could be returned to U.S. households in various ways.

This analysis considers two revenue-recycling methods that the government might use:

- Reducing corporate taxes, or
- Providing each household with an identical lump-sum rebate.

Of course, the government could use that revenue in many other ways, such as paying down the national debt, spending more on government programs, or decreasing certain taxes that discourage economic activity. CBO chose the alternatives above because they illustrate a wide range of distributional effects that might result from an allowance-trading policy.

The total cost of a carbon-allowance program would depend on two additional factors: how extensively the government tried to reduce total carbon emissions and whether the trading program was international (involving the buying and selling of allowances with other countries) or limited to the United States. This analysis assumes that the government would cut U.S. carbon emissions by 15 percent. That figure is a hypothetical limit that was chosen because it lies between the cuts proposed by various policy groups. The analysis looks at effects under both domestic allowance trading (outlined below) and international trading (discussed later).

Distributional Effects of Carbon-Allowance Trading

Although the government might impose the allowance requirements on companies, the costs of the policy would ultimately fall on households. Companies would be likely to pass the costs associated with those requirements on to households by raising the prices of consumer products. The price increase for a product would be proportional to its "carbon content," the amount of carbon emitted from the fossil fuels used in its production. Those increases would be regressive —that is, they would place a relatively greater burden on lower-income households than on higher-income households—for two reasons. First, lower-income households generally consume a larger share of their income than higher-income households do, and second, a greater percentage of their income is spent on energy products (such as gasoline, electricity, and fuel for heating and cooking), which are the most carbon-intensive goods.

Like the policy costs, the value of the carbon allowances would also accrue to households. If the government gave allowances away, a large share of their value would go to households that were shareholders of the firms that received the allowances. Those households have disproportionately higher income. Likewise, if the government used its share of the allowances' value to reduce corporate taxes, households that owned capital (also disproportionately high-income households, though not to as great an extent as shareholders) would gain. If the government converted its share into lump-sum payments, all households would benefit.

CBO analyzed four allowance-trading scenarios, each incorporating one of the two allocation methods and one of the two revenue-recycling strategies described above. The analysis looked at how each scenario would affect average household income in five

quintiles—categories that each contain one-fifth of all U.S. households, ranked by income.

Results of the Analysis

Of the four scenarios, the free distribution of allowances combined with a cut in corporate taxes would be the most regressive. Average annual household income in the highest quintile would increase by $1,810, or 1.8 percent, under that scenario, whereas average household income in the lowest quintile would fall by $530, or 3.1 percent (see Summary Table 1). Lower-income households would incur losses because they would pay higher prices for goods but would receive little of the allowances' value.

By contrast, auctioning off allowances and using the revenue to provide households with lump-sum rebates would have a progressive distributional effect, in that households in the highest income quintile would bear the greatest share of the policy costs. Average household income in that quintile would decline by $940, or 0.9 percent, a year. At the other end of the distribution, average household income in the lowest quintile would increase by $310, or 1.8 percent. Thus, if the government chose to auction off carbon allowances, it would have enough revenue to fully offset the regressivity of the policy-induced price increases by issuing lump-sum payments.

If the government instead gave the allowances away, it would have less revenue available to offset the negative effects on low-income households through lump-sum payments. In addition, the share of allowance value that would accrue to firms receiving the allowances would tend to benefit high-income households. Thus, the ultimate effects of that scenario would be regressive (though not as regressive as the scenario that would combine free distribution with a cut in corporate taxes). Households in the highest quintile would be better off as a result of those policies (with average annual income increasing by $1,250, or 1.2 percent), but households in lower quintiles would tend to be worse off (with average income decreasing by $340, or 2 percent, in the bottom quintile).

Auctioning off the allowances and using all of their value to cut corporate taxes would have a slightly

Summary Table 1.
The Distributional Effects and Potential for Efficiency Gains of Various Scenarios for Allocating Carbon Allowances and Recycling the Government's Revenue

	Change in Real Annual Income for				Potential for Gains in Economic Efficiency
	Lowest Quintile		Highest Quintile		
Allowance-Allocation/Revenue-Recycling Scenario	Dollars	Percent	Dollars	Percent	
Free Distribution/Decrease in Corporate Taxes	-530	-3.1	1,810	1.8	Some
Auction/Decrease in Corporate Taxes	-510	-3.0	1,510	1.5	Greatest
Free Distribution/Lump-Sum Rebate	-340	-2.0	1,250	1.2	None
Auction/Lump-Sum Rebate	310	1.8	-940	-0.9	None

SOURCE: Congressional Budget Office.

NOTE: Quintiles are categories that each contain one-fifth of U.S. households ranked by real (inflation-adjusted) annual income. The numbers in this table derive from data on each quintile's cash consumption and estimates of cash income. More complete measures of income and consumption would include in-kind items, such as employer-paid health benefits or food stamps, and thus could yield somewhat different findings. Data limitations preclude such measures, however. Consequently, these numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as exact figures.

less regressive effect than giving the allowances away and using the government's share of their value to decrease corporate taxes. Average annual household income in the top quintile would rise by $1,510, or 1.5 percent, and average household income in the bottom quintile would fall by $510, or 3 percent.

Limitations of the Analysis

Those distributional effects of a trading policy for carbon allowances should be viewed as illustrative rather than exact. Although the general pattern of gainers and losers and the relative regressivity of the four scenarios would be unlikely to change, shortcomings in the data available for this analysis cast doubt on the exact income figures. In addition, the results given here represent average national effects; the impact on any particular household or region could differ.

The available data on households' consumption and income make it difficult to precisely measure how regressive the costs of a carbon-allowance program would be. The Consumer Expenditure Survey (CEX) produced by the Bureau of Labor Statistics provides the best information about what households buy, but available data on income (from the Census Bureau's Current Population Survey and the Internal Revenue Service's Statistics of Income database) appear to understate the resources that some households have available. That understatement is particularly important at the bottom end of the income distribution, where unreported income and private transfers (such as gifts from family members) may constitute a larger share of households' resources. When income is understated, consumption can look unreasonably large compared with income. For example, according to the reported expenditure and income data, the average household in the lowest quintile spent more than twice its after-tax income (135 percent more) in 1998. If that ratio is higher than actually occurred, the policy costs of a carbon-allowance program—which depend on households' levels of consumption—will appear more regressive than they really would be.

Data on net worth (assets minus liabilities) rather than income yield a very different picture of consumption-to-income ratios. Changes in net worth can be used to infer saving rates and, by extension, both consumption and consumption-to-income ratios. That approach suggests that the average household in the lowest quintile spent just 17 percent more—rather than 135 percent more—than its income in 1998.

For this analysis, CBO used the consumption data reported in the CEX and adjusted the income estimates for lower-income households upward so that consumption-to-income ratios matched those obtained from data about net worth. If the resulting ratios understate low-income households' true consumption relative to their income, all four policy scenarios analyzed in this study would be more regressive than CBO estimated. But if the consumption-to-income ratios are overstated, all of the scenarios would be less regressive than estimated.

Effects of Carbon-Allowance Trading on Economic Efficiency

One reason that some policy analysts favor auctioning off allowances is that the government could use auction revenue to reduce the costs that a cut in carbon emissions would impose on the economy. Such cost reduction could occur if the government used the revenue to lower taxes that discourage economic activity by discouraging labor and investment (such as taxes on capital, labor, and personal income). By decreasing those taxes, the government would provide an incentive for households to save, invest, or work more. That would increase the supply of capital and labor and in turn generate efficiency gains—that is, lead to a higher level of economic activity. Measuring the potential efficiency gains associated with different allowance-allocation and revenue-recycling strategies is beyond the scope of this analysis, but some general conclusions are possible.

Not all of the policies that CBO examined would produce gains in economic efficiency. Recycling allowance revenue through lump-sum rebates to households would not encourage additional work, saving, or investment by households. Decreasing corporate taxes could produce such gains, but the potential for gains would be greater if the government auctioned off al-

lowances rather than gave them away. For one thing, an auction would yield more revenue for the government, so the decrease in corporate taxes could be larger. And for another, the share of allowance value that would accrue to households that held stock in companies receiving free allowances would not produce any efficiency gains. Thus, combining an allowance auction with a corporate tax cut would create both a more efficient and a more equitable outcome than combining free distribution of allowances with such a tax cut would.

Distributional Effects of International Allowance Trading

Because temperature levels are affected by the total amount of CO_2 in the atmosphere, and because carbon emissions are subject to international agreements (such as the 1997 Kyoto Protocol), some policy analysts have suggested that carbon allowances be traded internationally. How would such trading change the distributional effects of the various policy scenarios that CBO examined? If the U.S. government issued the same number of allowances (corresponding to a 15 percent cut in carbon emissions) but domestic firms were allowed to buy additional foreign allowances, the worldwide price of allowances would fall and the level of U.S. carbon emissions would rise. The reason is that some foreign companies might be able to reduce their emissions at a lower cost than U.S. companies could, which would give them an incentive to sell their excess allowances in the United States. (The additional allowances would let U.S. companies emit more carbon.) At the same time, the availability of low-cost foreign allowances would reduce the price, and thus the value, of all allowances.

International trading would make U.S. households better off overall, but that benefit would not be distributed uniformly. Households that would lose income under a particular allowance-allocation and revenue-recycling scenario with domestic trading would be better off with international trading. But households that would experience an income gain under a given domestic scenario would be relatively worse off with international trading.

Conclusions

If the government gave away carbon allowances to U.S. firms, the ultimate effects on U.S. households would be regressive in their distribution. That would be true even if the government tried to offset the regressivity of the resulting price increases by using the share of the allowances' value that it received through taxes (and did not need to cover higher costs itself) to give households lump-sum rebates.

If the government sold carbon allowances through an auction, by contrast, the ultimate distributional effects would depend on how the government chose to use the auction revenue. If it made a uniform lump-sum payment to all households, the effects would be progressive, with the costs of the policy borne primarily by high-income households. If instead the government used that revenue to decrease corporate taxes, the effects would be regressive.

Thus, the ultimate distributional effects (or incidence) of a carbon trading program are largely a function of how the program is designed. Specifically, the incidence depends on how the government decides to allocate the allowances and to use its share of the allowances' total value. The distributional implications of those decisions are an important consideration for policymakers because the amount of wealth that would be redistributed by a U.S. carbon trading policy could reach into the tens or hundreds of billions of dollars.

Chapter One

Introduction

Since the 19th century, scientists have known that concentrations of carbon dioxide (CO_2) in the atmosphere affect temperatures. Changes in those concentrations have raised concern about the impact that human actions may be having on the Earth's climate. But uncertainty about the science and effects of climate change and about the potential cost of reducing CO_2 emissions has thwarted efforts to agree on what actions, if any, should be taken.

One area that is subject to general agreement is that any actions to reduce CO_2 emissions (referred to in this study as carbon emissions) should be cost-effective; in other words, they should achieve the desired reduction at the lowest possible cost. That desire has sparked interest in a trading program for carbon emissions. Under such a program, the U.S. government would set an overall limit on domestic carbon emissions—perhaps as part of an international agreement—and U.S. firms would determine the manner in which to meet that limit. They would make that determination through buying and selling rights (or allowances) to emit a certain amount of carbon. Trading in allowances could be limited to U.S. allowances or could include those of other countries. (In addition, gases besides CO_2 that have been shown to affect temperatures could be included in a trading program. The wider scope of such a program, however, would make monitoring and enforcement more complicated.)

A growing body of research has looked at how the design of a trading program for carbon allowances would affect economic efficiency—that is, the overall level of economic activity. This study touches on that topic but focuses mainly on how the economic effects would be distributed among U.S. households at different income levels. It examines four policy scenarios, each including one of two methods for allocating allowances (free distribution or an auction) and one of two strategies for using the additional government revenue that would result (cutting corporate taxes or paying a uniform rebate to all U.S. households).

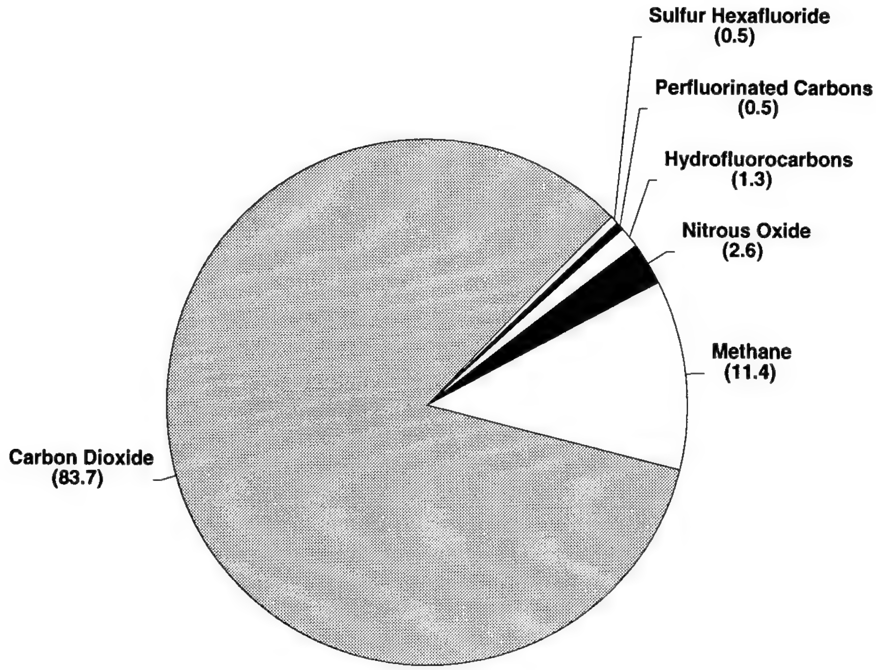
Efforts to Prevent Climate Change

Carbon dioxide in the atmosphere affects temperatures by retaining heat from the sun. It is produced by (among other things) burning any fuel that contains carbon, such as coal, oil, or natural gas. As a result, man-made carbon emissions increased greatly during the industrial revolution when use of fossil fuels surged.[1]

For many years, scientists assumed that man-made carbon emissions were being absorbed by the oceans. But that assumption changed in the late 1950s when scientists took measurements in Hawaii and found that atmospheric concentrations of CO_2 were rising steadily. Later research revealed that other

1. For a more detailed discussion of the science and politics of climate change, see J.W. Anderson, *The Kyoto Protocol on Climate Change: Background, Unresolved Issues and Next Steps* (Washington, D.C.: Resources for the Future, January 1998). Much of this discussion was drawn from that report.

Figure 1.
Composition of Total U.S. Emissions of Greenhouse Gases, 1995 (In percent)



SOURCE: Congressional Budget Office based on information from Department of State, *Climate Action Report* (1997), p. 57.

common gases, such as methane and nitrous oxide, could also affect climate. Because the process by which such gases trap heat in the atmosphere is sometimes called the greenhouse effect, the gases are known as greenhouse gases.

By the late 1980s, climate change had emerged as a major political issue transcending national boundaries. In December 1988, the U.N. General Assembly established the Intergovernmental Panel on Climate Change (IPCC) to review scientific data on the subject. The most recent IPCC report, issued in 1996, concluded that statistical evidence "now points towards a discernible human influence on global climate."[2] However, that report highlighted the difficulties of determining the magnitude of human effects and distinguishing between human and natural effects on climate. In addition, public understanding of the potential severity and impact of climate change continues to evolve. Some recent research has focused on the possible benefits of global warming as well as the potential harm.[3]

In December 1997, officials from nearly every nation met in Kyoto, Japan, to discuss climate change. The outcome of that meeting was the Kyoto Protocol, which set specific targets by which each country should reduce its emissions of greenhouse gases. Those targets would be in effect from 2008 through 2012. Together, they would cut emissions from industrialized countries by 5.2 percent from the 1990 level.[4] (Targets vary between countries, but the total level of

2. A review draft of the latest IPCC report was released in April 2000, but the final report is not scheduled to be issued until early 2001.

3. For a review of that research, see Robert Mendelsohn, *The Greening of Global Warming* (Washington, D.C.: American Enterprise Institute for Public Policy Research, 1999).

4. More specifically, the emissions from countries that agreed to binding limits under the Kyoto Protocol are expected to fall by 5.2 percent. Those countries include most developed nations and the transitional economies of the former Soviet bloc.

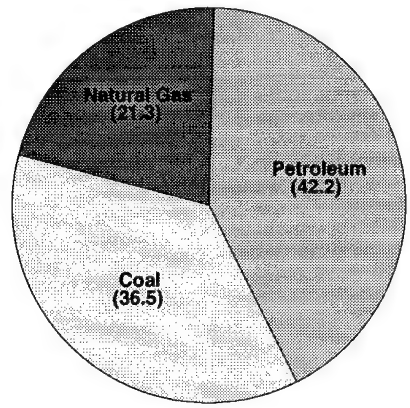
worldwide emissions is the key consideration because the geographic distribution of greenhouse gas emissions does not affect the potential for global warming.) The Kyoto Protocol would require the United States to reduce its emissions of greenhouse gases by 7 percent from the 1990 level. That would correspond to a cut of approximately 30 percent from the level otherwise expected to occur during the 2008-2012 period.

The protocol covers six greenhouse gases. Of those, carbon dioxide accounted for nearly 84 percent of U.S. greenhouse gas emissions in 1995 (see Figure 1). Virtually all U.S. carbon emissions result from combustion of fossil fuels. Petroleum was the largest source in 1998, followed by coal and natural gas (see Figure 2). Of those three, coal emits the most carbon per amount of heat generated and natural gas the least. For example, carbon emissions would be 77 percent higher if a given amount of heat was generated by coal rather than by natural gas and 20 percent higher if it was generated by petroleum rather than by natural gas. Any attempt to achieve large reductions in U.S. emissions would require shifting from carbon-intensive fossil fuels such as coal to less-carbon-intensive ones such as natural gas. Switching to renewable sources of energy (such as hydropower or nuclear power) or reducing energy use would also decrease emissions.

As of January 13, 2000, the Kyoto Protocol had been signed by 84 countries and ratified by 22.[5] The agreement is intended to take effect 90 days after the 55th government ratifies it, assuming that those 55 countries accounted for at least 55 percent of the carbon emissions of developed countries in 1990.

The Kyoto Protocol has not yet gone to the U.S. Senate for a vote on ratification. Some difficult issues must be resolved first, including whether large developing countries—such as China, Mexico, and South Korea—will agree to limits on their emissions. Reducing greenhouse gases would be relatively inexpensive in those countries, where fossil fuel is used inefficiently. Thus, the cost of meeting its own emission target would be significantly lower if the United States could do so in part by financing low-cost emission

Figure 2.
Sources of U.S. Emissions of Carbon Dioxide, 1998 (In percent)



SOURCE: Congressional Budget Office based on information from Department of Energy, Energy Information Administration.

reductions in developing countries.[6] But developing countries fear that limits on emissions could impede their growth.

Uncertainty about the severity and effects of climate change and the cost of cutting emissions—along with numerous complications involved in coordinating with other countries—has prevented agreement about how much the United States should reduce its greenhouse gas emissions. If reductions are undertaken, however, most people would agree that they should be achieved at the lowest possible cost to the U.S. economy. For that reason, analysts and government officials have focused on the use of economic incentives rather than one-size-fits-all regulations to cut emissions. A carbon trading program is one form of economic incentive under consideration. Such a program could be launched in the context of an international agreement, such as the Kyoto Protocol, or on a unilateral basis.

5. See United Nations Framework Convention on Climate Change, "Kyoto Protocol Status of Ratification" (January 13, 2000), available at www.unfccc.de/resource/kpstats.pdf

6. Global temperature levels are affected by the total amount of CO_2 in the atmosphere, so foreign emission reductions should be just as effective as U.S. emission reductions. If international trading of carbon allowances occurred, the United States could receive credit toward its domestic limit by purchasing low-cost foreign emission reductions.

Trading Programs for Emission Allowances

The concept of trading in pollution rights—what this study calls emission allowances—first appeared in the academic literature in 1968. Trading programs can be attractive alternatives to more traditional approaches that mandate specific pollution limits for all sources. Their primary advantage is that they can lower the cost of achieving an environmental goal by giving participants some flexibility.

Trading programs have been used to achieve a variety of environmental objectives in the United States. A federal program for sulfur dioxide (SO_2) emissions began in 1995 in order to reduce damage from acid rain. Major electricity-generating units received an allocation of tradable allowances, each permitting the discharge of one ton of SO_2. Taken together, those allowances corresponded to a specific level of SO_2 allowed for those electricity-generating units during the 1995-1999 period. Firms that wished to emit more SO_2 than their allowed level (that is, more than the amount they were entitled to by the number of allowances they were given) could buy allowances from companies that had reduced their emissions below their allowed levels.

Besides the SO_2 program, the federal government has successfully used trading programs to gradually lower the amount of lead in gasoline and to phase out the use of ozone-depleting chemicals.[7] More recently, the Environmental Protection Agency (EPA) issued a rule that would require 22 eastern states and the District of Columbia to reduce their emissions of nitrogen oxides, the principal component of smog.[8]

Under a carbon trading program, the government would set a limit on total U.S. carbon emissions and then distribute allowances for those emissions. One allowance would permit the emission of one metric ton of carbon dioxide. Because different fuels release different amounts of carbon when they burn, the number of allowances required for a given amount of heat output would vary among fuels. For example, the amount of carbon released per million British thermal units (MBTU) of coal is 1.8 times the amount released per MBTU of natural gas. Thus, the number of allowances required per MBTU of coal used would be 1.8 times greater than the number required per MBTU of natural gas. Some sources of energy, such as solar and nuclear, do not result in the release of any carbon, so no allowances would be required for their use. The difference in allowance requirements among fuels would result in price increases that would give companies and households an economic incentive to use less-carbon-intensive fuels and to use fuels more efficiently.

Methods for Allocating Emission Allowances

An important decision in designing a trading program is how to allocate allowances. Among its primary allocation methods, the federal government could give allowances to companies or sell the allowances through an auction. The government has distributed allowances for free in its past environmental trading programs. For example, allowances for SO_2 and ozone-depleting chemicals were issued on the basis of previous production levels.[9] In the lead program, refiners "earned" rights to the use of lead by producing leaded gasoline—that is, each gallon of gasoline they made entitled them to a certain number of lead credits.

7. For an overview of the wide variety of state and federal environmental trading programs, see Robert C. Anderson and Andrew Q. Lohof, *The United States' Experience with Economic Incentives in Environmental Pollution Control Policy* (report prepared for the Environmental Protection Agency by the Environmental Law Institute, August 1997).

8. For more information about that program, see Congressional Budget Office, *Factors Affecting the Relative Success of EPA's NO_x Cap-and-Trade Program*, CBO Paper (June 1998).

9. About 1.7 percent of the 8.69 million sulfur dioxide allowances issued in 1995 were auctioned off by the EPA; see A. Denny Ellerman and others, *Emissions Trading Under the U.S. Acid Rain Program: Evaluation of Compliance Costs and Allowance Market Performance* (Cambridge, Mass.: MIT Center for Energy and Environmental Policy Research, October 1997), p. 12. The purpose of those auctions was to ensure a supply of allowances for new utilities and, for early auctions, to provide a price signal for allowances in a nascent market; see Renee Rico, "The U.S. Allowance Trading System for Sulfur Dioxide: An Update on Market Experience," *Environmental and Resource Economics*, vol. 5, no. 2 (1995), p.125.

They could use those credits themselves or sell them to other refiners.[10]

Distributing allowances for free could make a limit on carbon emissions more acceptable to the companies involved. The value of an individual allowance is represented by the price at which it can be sold. If allowances were auctioned, the federal government would receive virtually all of that value. In contrast, if allowances were freely distributed, the majority of that value would go to the recipient firms—who would have higher profits as a result—and would ultimately benefit their shareholders.[11]

Although giving away allowances could make a trading program more acceptable to the regulated entities, distributing allowances through an auction could also have benefits. The revenue raised from an auction could be used to cut existing taxes that cause distortions in the economy. For example, taxes on capital discourage investment and saving, and taxes on labor can discourage people from working more and employers from using more labor. If the revenue raised by auctioning off emission allowances was used to cut taxes on capital and labor, those adverse incentives would be reduced. But if allowances were given away, a large share of their value would go to the regulated community and would thus be unavailable to cut existing taxes.

Decisions about how to allocate allowances and how to use the government's share of their value would affect households in different income brackets differently. In other words, each policy would have unique distributional effects. Some people argue that carbon allowances should be auctioned off and the resulting revenue should be used to make the trading program more equitable. For example, the Corporation for Enterprise Development has proposed that the revenue from a carbon auction be put into a "Sky Trust."[12] The bulk of that fund would be issued as uniform payments to each U.S. citizen. That proposal is predicated on the idea that everyone owns the "rights" to the sky and that each person should receive an equal amount of the revenue generated by selling those rights.

Analysts at Resources for the Future have also proposed that carbon allowances be auctioned off and the revenues returned to households in a way that makes the policy more equitable.[13] They argue that since a limit on carbon emissions would increase energy prices, a trading program would be equitable only if it compensated households for those price increases. They propose that 75 percent of auction proceeds fund a direct payment to all U.S. households (based on legal residency). The remaining 25 percent would be given to states on the basis of how much energy their low-income households use and how vulnerable their industries are to higher energy costs.

10. The EPA allowed refiners and importers to sell lead credits beginning in 1983. Those companies generated credits for sale if their individual quarterly average for actual lead used in their leaded gasoline was less than the regulatory limit for the lead content of leaded gasoline. That limit was decreased over time until lead was completely phased out of gasoline.

11. The trading program for ozone-depleting chemicals was accompanied by a tax on those chemicals. The tax was intended to accelerate the phaseout of the chemicals, raise revenue for the federal government, and capture some of the windfall revenues that the producers of ozone-depleting chemicals received when the cap on those chemicals led to higher prices.

12. See Peter Barnes and Gabriel Wishik, "Who Will Own the Sky?" *Journal of Environmental Economics* (forthcoming).

13. See Raymond Kopp and others, "A Proposal for Credible Early Action in U.S. Climate Policy" (Resources for the Future, Washington, D.C.), available at www.weathervane.rff.org/features/feature060.html

Chapter Two

The Overall Economic Effects of a Carbon Trading Program

One of the first steps in designing a trading program for pollution allowances is to determine the desired limit on emissions. This study assumes that U.S. emissions of carbon dioxide would be cut by 15 percent. That figure was chosen arbitrarily because it lies between the limits in other carbon-restriction proposals. (The Kyoto Protocol, for example, would compel the United States to reduce carbon emissions by approximately 30 percent from the average level in 2008 through 2012. The proposal by Resources for the Future described in the previous chapter would decrease carbon emissions gradually, from a 10 percent cut by 2002 to a 20 percent cut by 2008.) The distributional effects described in this study would change roughly proportionately with larger or smaller limits on emissions.

After setting its limit, the government would distribute carbon allowances, with each allowance permitting the emission of one metric ton of carbon dioxide. Some analysts advocate using an "upstream" trading program that would require producers and importers of fossil fuels to hold an allowance for each metric ton of carbon that was emitted when their fuel was burned.[1] That design would limit the number of entities that would need to be monitored and minimize the costs of implementing the policy. This analysis assumes such a design. However, because firms would be free to buy and sell allowances after the initial distribution, the government could distribute the allowances either to the upstream firms that were required to hold them or to "downstream" firms, such as utilities and industrial boilers.

The overall economic effects of the carbon trading program would differ depending on whether allowances were traded only within the United States or internationally. In the case of an international trading program, the availability of carbon allowances from other countries would lower the total cost to the United States of achieving its limit on carbon emissions.

Effects Under Domestic Trading

In a domestic trading program, the level of U.S. carbon emissions would be limited to the number of allowances issued by the U.S. government. This study uses 1998 emissions as a policy baseline (to be consistent with the consumer expenditure data and tax return data used later in the analysis). U.S. carbon emissions totaled 1.5 billion metric tons in 1998, so a 15 percent reduction would limit total emissions to 1.28 billion metric tons (see Table 1). Thus, in this analysis, the federal government would issue 1.28 billion allowances.

1. For a discussion of the advantages of an upstream trading design, see Carolyn Fischer, Suzi Kerr, and Michael Toman, "Using Emissions Trading to Regulate U.S. Greenhouse Gas Emissions: An Overview of Policy Design and Implementation Issues," *National Tax Journal*, vol. 51, no. 3 (September 1998).

Table 1.
Comparison of Domestic and International Carbon-Allowance Trading Assuming a 15 Percent Cut in Emissions

	Domestic Trading	International Trading
Carbon Dioxide Emissions (Billions of metric tons)		
U.S. Emissions in 1998 (Prepolicy baseline)	1.50	1.50
Level of Emissions for Which Allowances Would Be Issued	1.28	1.28
U.S. Emissions After Policy Change	1.28	1.35
Price per Allowance (1998 dollars)		
Price[a]	100	60
Total Costs and Allowance Value (Billions of 1998 dollars)		
Value of U.S. Allowances Issued	128	77
U.S. Spending on Allowances (Allowance costs)	128	81
Substitution Costs[b]	11	4
Share of Total Costs and Allowance Value Borne by Various Parties (Percent)		
Value of U.S. Allowances Issued		
Government share under free distribution	45	45
Government share under auction	100	100
U.S. Spending on Allowances (Allowance costs)		
Private share	87	87
Government share	13	13
Substitution Costs		
Private share	87	87
Government share	13	13

SOURCE: Congressional Budget Office.

NOTE: The cost estimates in this table are based on various assumptions, which are outlined in Box 1 on pages 12 and 13.

a. Based on 1998 prepolicy carbon emissions, a prepolicy price of $307 per metric ton of carbon emitted, and a price-responsiveness estimate of -0.57.

b. Based on the price per allowance, the change in carbon emissions, a prepolicy price of $307 per metric ton of carbon emitted, and a price-responsiveness estimate of -0.57.

The price at which allowances would be bought and sold would be determined by the size of the carbon limit and the cost of reducing carbon emissions. The bigger the limit on emissions and the harder it was for households and intermediate producers (such as utilities) to reduce their use of fossil fuels, the more the allowances would cost. The price per allowance would reflect the economy's relative ease or difficulty in adjusting to a lower level of carbon emissions; that price would be the same regardless of whether the government initially gave the allowances to firms or sold them through an auction.[2] Based on empirical

2. That statement assumes efficient trading of allowances following the initial distribution. It also assumes that the incentives for innovation (and, hence, the price of an allowance) would not be affected by the

studies of the extent to which carbon emissions would decrease as the price of emitting carbon increased, the Congressional Budget Office (CBO) estimates that a 15 percent cut in emissions would correspond to an allowance price of $100.[3]

Policy Costs

Under an allowance-trading program, obtaining allowances would become a cost of doing business. In the long run, producers and importers of fossil fuels would pass that cost on to households in the form of higher prices.[4] The price that users paid for fossil fuels would rise in proportion to the fuels' carbon emissions, and the price of all goods would rise in proportion to their "carbon content"—the carbon emissions generated by the fossil fuels used in their production. For example, given an allowance price of $100, the price of electricity would rise by 34 percent and the price of gasoline and oil would rise by 33 percent (see Table 2).

CBO estimates that an allowance price of $100 would cause a 2.8 percent increase in the general price level. That rise would produce automatic increases in income for households that receive transfer payments from the federal government (such as Social Security benefits) that are indexed to the price level. This study accounts for that effect by indexing federal pensions and Social Security and Supplemental Security Income payments to the increase in the general price level.

The rise in consumer prices resulting from a carbon trading policy would impose two types of costs on households: substitution costs and allowance costs.

Substitution Costs. Higher prices would encourage households and intermediate producers to decrease their consumption of goods with a high carbon content. Substitution costs are the costs that households would bear as a result of those efforts. They could include inconvenience costs (for example, from households' driving less) as well as higher prices that households would pay to intermediate producers that had reduced their carbon consumption (for example, higher electricity prices to finance utilities that had replaced coal with lower-carbon-emitting fuels, such as natural gas or renewable energy sources).

CBO estimates that the substitution costs resulting from a 15 percent cut in emissions would total $11 billion under domestic allowance trading (see Table 1).[5] Such costs represent a cost to the U.S. economy as a whole rather than a transfer of income within the economy. Thus, $11 billion is the cost that the United States would bear to decrease its carbon consumption. The environmental benefits of reducing carbon emissions may or may not exceed that cost; however, such

method of distribution. Further, it does not account for any potential changes in the allowance price that might result from the efficiency gains obtained when revenue was used to cut existing taxes.

3. CBO estimated that price using a responsiveness estimate of -0.57, which was found by geometrically averaging the results of nine models that empirically estimated the responsiveness of carbon emissions to carbon prices. Those nine models were the Second Generation Model used by Batelle Laboratory and the Clinton Administration; the Multi-Sector, Multi-Regional Trade Model of Charles Rivers Associates and the University of Colorado; the National Energy Modeling System of the Department of Energy's Energy Information Administration; the Model for Evaluating Regional and Global Effects of Greenhouse Gas Reduction Policies used by the Electric Power Research Institute and Stanford University; the Jorgenson-Wilcoxen-Slesnick Model; the Emissions Prediction and Policy Analysis Model of the Massachusetts Institute of Technology; and models by Data Resources, Inc., Oxford Economic Forecasting, and WEFA, Inc. The estimates from those nine models range from a high of -1.30 to a low of -0.41, although six of the estimates lie between -0.50 and -0.41.

4. Fossil-fuel prices would rise even if the federal government gave allowances away. Since the allowances have value, firms that received one would have the option of forgoing production and selling the allowance. For them to be willing to hold on to the allowance and continue to produce, the price of the fossil fuel would need to rise by the price of the allowance.

5. That estimate is based on the price per allowance, the change in carbon emissions, a price-responsiveness estimate of -0.57, and a prepolicy price of $307 per metric ton of carbon emitted. Note that the price increases caused by the limit on emissions would lower real wages and real returns on capital. Those reductions would tend to reduce further the level of employment and investment in the economy and thereby add to the distortions created by the tax system. That result is called the "tax-interaction effect." Some economists argue that the tax-interaction effect could be very large; see Ian Parry, Roberton C. Williams, and Lawrence Goulder, "When Can Carbon Abatement Policies Increase Welfare? The Fundamental Role of Distorted Factor Markets," *Journal of Environmental Economics and Management,* vol. 37 (1999). For example, based on a model that includes only labor, Parry, Williams, and Goulder find that the total cost of reducing carbon emissions by 15 percent would more than double because of the tax-interaction effect. Estimating the magnitude of that effect is beyond the scope of this study. However, their results suggest that the tax interaction could more than double the substitution costs in this analysis. The tax-interaction effect would be reduced if the revenue collected as a result of the allowance policy was used to offset existing distortionary taxes, such as those on capital and labor.

Table 2.
Price Increases for Various Consumer Goods Assuming a $100 Price per Carbon Allowance

	Increase in Price (Percent)
Food	
Consumed off premises	2.6
Consumed on premises	1.4
Furnished to employees	2.8
Tobacco Products	1.1
Alcohol	
Consumed off premises	2.3
Consumed on premises	1.4
Clothing and Related Items	
Clothing and shoes	2.3
Clothing services	1.4
Jewelry and watches	2.0
Toilet articles and preparations	2.3
Barbershop, beauty parlor, and health club services	1.4
Housing and Related Items	
Rent for tenant-occupied nonfarm dwellings	0.6
Rent for other lodgings	1.4
Furniture and durable household equipment	2.3
Nondurable household supplies and equipment	0
Electricity	34.2
Natural gas	55.9
Water, sewer, and other sanitary services	1.7
Fuel oil and coal	34.5
Telephone and telegraph	0.9
Domestic service and other household operations	2.8
Medical Care	1.4
Business Services	0.9
Expense of Handling Life Insurance	0.9
Automotive and Related Items	
New and used motor vehicles	2.3
Tires, tubes, accessories, and other parts	2.6
Repair, greasing, washing, parking, storage, and rental	1.4
Gasoline and oil	33.1
Bridge, tunnel, ferry, and road tolls	1.7
Automobile insurance	0.9
Other Transportation	
Mass transit systems	5.4
Taxicab, railway, bus, and other travel expenses	5.4
Airline fares	5.4
Recreation	
Books and maps	2.0
Magazines, newspapers, and nondurable toys	2.3
Recreation and sports equipment	2.0
Other recreation services	1.4
Net receipts from pari-mutuel betting	1.4
Education	
Higher education	1.4
Nursery, elementary, and secondary education	1.4
Other education services	1.4
Religious and Welfare Activities	1.4

SOURCE: Congressional Budget Office based on Gilbert E. Metcalf, "A Distributional Analysis of Green Tax Reforms," *National Tax Journal*, vol. 52, no. 4 (December 1999), pp. 655-681.

an assessment is beyond the scope of this analysis.[6] That cost estimate and the others in Table 1 rely on several key assumptions (see Box 1). If those assumptions did not hold, the total costs of the policy would be different from the substitution costs used in this analysis.

CBO's estimate of substitution costs does not include the transitional losses that would occur as the economy adjusted to the new level of fossil-fuel consumption. For example, some coal mines could shut down, causing job displacement and a loss of the specialized capital that was invested in those mines. Such losses are important, but they are not estimated in this analysis. This study takes a long-term perspective in which resources have had time to adjust to the new consumption level.

Allowance Costs. Besides the costs associated with reducing consumption of carbon-intensive goods, households would also bear the costs of continuing to consume some of those goods. By CBO's estimate, those allowance costs would total $128 billion (reflecting the 1.28 billion allowances issued and the $100 price per allowance). Unlike substitution costs, allowance costs would not be a cost to the U.S. economy as a whole. Rather, they represent a transfer of income from households that would pay more because of the allowance policy to households that would receive the value of the allowances.[7]

Allowance costs would ultimately fall on households in the form of higher prices, with price increases reflecting the carbon content of each good. The cost that any individual household bore would be determined by what quantity of carbon-intensive goods it purchased.

This study treats government consumption of carbon differently than private-sector consumption. The government accounted for approximately 13 percent of total carbon consumption in 1998, CBO estimates.[8] Thus, it would bear 13 percent of both allowance costs and substitution costs. Unlike private-sector cost increases, government cost increases would probably not be passed on to households in proportion to their consumption of carbon-intensive goods. Instead, this study assumes that the government would pay for its increased costs with the share of the allowances' value that it received through taxes on corporate profits or auction revenue. (It would pay in the same way for the increase in transfer payments, such as Social Security, that resulted from the general price increase.)

Allowance Value

A carbon trading program would redistribute income from households that ultimately pay for the allowances (through higher prices) to households that ultimately receive the value of the allowances. In this analysis, the trading program would transfer $128 billion of income within the U.S. economy—more than 10 times what it would cost the economy as a whole (through substitution costs) to cut carbon emissions.

How that $128 billion in allowance value was distributed among households would depend on two decisions by the government: how it allocated allowances and how it used the share of the allowances' value that it would receive under a given method of allocation.

6. That assessment would compare the benefits of reducing carbon emissions with the total costs of the limit on emissions, including substitution costs and the increased distortion in labor and capital markets that the policy might create (the tax-interaction effect described in the previous footnote).

7. If a carbon trading program would reduce the overall welfare of U.S. citizens (because the total costs of the program would be greater than the total benefits), some researchers would argue that the lobbying costs associated with firms' attempts to obtain allowances should be included in the real cost of the policy; see Gordon Tullock, "Rent Seeking and Tax Reform," *Contemporary Policy Issues*, vol. 6, no. 4 (October 1988). Further, some researchers argue that under those same circumstances, the true cost of the policy must account for the cost of other inefficient policies that were tied to it through vote trading among legislators; see Gordon Tullock, "Where Is the Rectangle?" *Public Choice*, vol. 91, no. 2 (September 1998). Finally, other researchers point out that inefficient policies resulting from special interests' attempts to gain at the expense of society as a whole (called rent seeking) could be a necessary part of the process of passing laws that enhance the welfare of society; see Gordon C. Rausser, "Predatory Versus Productive Government: The Case of U.S. Agricultural Policies," *Journal of Economic Perspectives*, vol. 6, no. 3 (Summer 1992). Determining whether a carbon trading program would increase or decrease overall welfare and whether rent-seeking activities would increase the cost of the policy is beyond the scope of this analysis.

8. That estimate includes the government's direct and indirect demand for carbon. The direct demand was obtained by examining the government's consumption of coal, oil, gas, and electricity. Its indirect demand was based on its share of total spending on goods and services (after adjusting for government payroll costs and capital depreciation).

Box 1.
Key Assumptions Underlying the Estimates of Total Costs

This study assumes that a carbon trading program would cover all potential sources of fossil-fuel-based carbon and would result in the least costly mix of emission reductions. Those are best-case assumptions; to the extent that they did not prove true, the cost of achieving a 15 percent cut in carbon emissions would be higher than this study estimates.

The Trading Program Would Include All Fossil-Fuel-Based Carbon

A program of economic incentives that covered all sources of fossil-fuel-based carbon emissions would have the greatest chance of minimizing the cost of meeting a limit on emissions. By contrast, a program that focused on carbon emissions in just one sector, such as the utility industry, could overlook potentially cheaper reductions in other sectors, such as transportation. The United States has millions of individual sources of carbon emissions, including power plants, motor vehicles, and lawn mowers. Thus, a trading program would have the greatest potential to capture all sources of carbon if it was implemented "upstream," covering suppliers of fossil fuels rather than users. This analysis assumes such a trading program.

Trading Would Result in the Least Costly Mix of Emission Reductions

The estimates of total costs used in this analysis (which are shown in Table 1) are based on the assumption that the restriction on emissions would be met at the lowest possible cost. In other words, allowance trading would occur until there were no more possible changes in the pattern of emission reductions that would lower the overall cost of meeting the restriction. Achieving that ideal in the real world is not always possible, however.[1]

Various uncertainties make projecting the cost of meeting a particular carbon restriction difficult. The estimates of total costs in this study rely on available empirical estimates of how responsive carbon emissions would be to changes in the price of a carbon allowance. Those price-responsiveness estimates in turn depend on many assumptions, including predictions about what technologies would be available to reduce the use of carbon-intensive fuels (such as technologies for saving energy and for using renewable energy sources); the cost of those technologies; and the willingness of residential, commercial, and industrial users to adopt them. To the extent that this study's estimates of price responsiveness overestimate or underestimate actual behavioral responses, the actual costs of achieving a 15 percent decrease in carbon emissions would be greater or less than the costs shown in Table 1.

In an upstream trading system, fossil-fuel suppliers would need to determine the price at which they were willing to buy or sell allowances. Making that determination could be difficult, particularly in the initial period while the market for allowances developed and companies gathered information about how

1. For example, according to an unpublished study, the costs of meeting the goals of the sulfur dioxide program in 1995 (its first year of operation) were 50 percent higher than they would have been if electric utilities had taken advantage of all potential trading opportunities. See Curtis Carlson and others, *SO_2 Control by Electric Utilities: What Are the Gains from Trade?* (draft, Resources for the Future, Washington, D.C., December 1997).

First, consider the case in which the government gives the allowances to producers and importers of fossil fuels. Those firms would make higher profits than they did before because the price of their fuel would rise (based on its carbon content and the price of the allowance) but their costs would not increase (since they would not have to pay for the allowances).[9] The government would capture approximately 45 percent of the value of the allowances through the taxes

9. Allowances would be traded among firms until the most efficient allocation was achieved. That trading would result in a transfer of funds among firms but not a cost increase for the industry as a whole. If the government were able to distribute allowances according to the most efficient allocation, then no trading would occur.

Box 1.
Continued

fossil-fuel production and prices were responding. Uncertainty about those responses could lead to volatile prices—and compound the difficulties in planning compliance—during that initial period. For example, during early trading in a market for nitrogen oxide allowances for 12 northeastern states, allowance prices ranged from $1,900 per ton to $7,500 per ton over the course of one year.[2] To the extent that information problems impeded trading, or that the market for allowances did not develop as smoothly as expected, the cost of achieving a particular limit on emissions would be higher than predicted.

To be effective in lowering the cost of restricting carbon emissions, the market for allowance trading would need to be competitive. That would be important regardless of whether allowances were distributed freely or through an auction. Concerns about market competition would arise if one participant's actions had the potential to influence the price of allowances, such as if the number of buyers and sellers was small or if a few participants controlled a large share of the market. Such concerns would be greater in an upstream market than in a downstream market because the number of regulated firms would be smaller. However, some analysts argue that market power would not be a problem in an upstream market for carbon allowances. Based on information about producers of oil and coal and suppliers of natural gas, they estimate that any one firm would make up less than 6 percent of the allowance market.[3]

In addition, allowance trading would be active only if transaction costs were low and enforcement was effective. Transaction costs include the cost of identifying potential trading partners and negotiating trades and the cost of obtaining necessary regulatory approval for trades.

Successful U.S. trading programs have had effective monitoring and reporting requirements.[4] Those requirements enabled the government to ensure that allowance sales were accompanied by actual reductions in pollution and that firms held the correct number of allowances for their emissions. Thus, the government could approve trades with minimal oversight—keeping transaction costs low—and at the same time ensure the integrity of the trading system. Effective monitoring and enforcement are more likely to be feasible in an upstream system, where the number of firms required to hold allowances is relatively small, than in a downstream system.

2. See James C. Letzelter and Marc W. Chupka, "Surviving the SIP Call: Fossil Plant Economics Under NO_x Control," *Public Utilities Fortnightly* (May 1999), pp. 44-51.

3. See Peter Cramton and Suzi Kerr, *Tradable Carbon Permit Auctions: How and Why to Auction Not Grandfather*, Discussion Paper 98-34 (Washington, D.C.: Resources for the Future, May 1998).

4. For more information about the role of transaction costs in trading programs, see Robert W. Hahn and Gordon L. Hester, "Marketable Permits: Lessons from Theory and Practice," *Ecology Law Quarterly*, vol. 16, no. 2 (1989); and Robert N. Stavins, "What Can We Learn from the Grand Policy Experiment? Lessons from SO_2 Allowance Trading," *Journal of Economic Perspectives*, vol. 12, no. 3 (Summer 1998).

that firms and their shareholders would pay as a result of those higher profits.[10] That percentage includes the value captured by federal, state, and local governments. The producers and importers would retain approximately 55 percent of the allowances' value, which would ultimately benefit households that were their shareholders.

10. The government's share of allowance value could be partially offset by lower collections of individual income tax. The reason is that policy-induced price increases would lead to automatic indexing of parts of the individual income tax, including the exemptions and tax brackets, thus causing income tax revenue to fall. However, that offsetting effect would most likely be small relative to the government's share of allowance value. (Income tax revenue would decline by the same amount if the government auctioned off allowances instead of giving them away.)

Alternatively, consider the case in which the government sells the allowances to fossil-fuel producers and importers through an auction. Again, the price of fuel would rise, but those firms would see no increase in profits because their costs would rise by the same amount since they would need to buy allowances through the auction. The government would capture virtually all of the allowances' value in the form of auction revenue.

In both cases—free distribution and an auction —the government would receive at least some of the allowances' value through increased revenue. The ultimate distribution of that value among households would depend on the government's decision about how to use the revenue. The government could pass it along to households in a variety of ways: by decreasing current tax collections, spending more on various programs, reducing the national debt, or providing a lump-sum rebate, which would be equivalent to dividing the revenue by the number of households and giving each household the same payment.

Different uses of the revenue would benefit households in various income brackets differently. The next chapter examines the distributional effects associated with two alternative strategies: reducing collections of corporate taxes by the amount of the revenue and providing a lump-sum rebate.[11] CBO chose those two from among the many potential uses because they illustrate a wide range of distributional effects that could result from an allowance-trading policy. (Chapter 3 describes how the distributional effects of cutting other types of existing taxes would compare with the results of this analysis.)

Effects Under International Trading

With international allowance trading, the U.S. government would distribute a quantity of allowances equal to the U.S. limit on carbon emissions. That amount would be the same as under domestic trading (in this case, enough to cut 1998 emissions by 15 percent). However, U.S. firms could purchase additional allowances from foreign companies that were able to reduce their carbon emissions at a lower cost. In developing countries, in particular, where fossil fuels are used less efficiently, the cost of cutting carbon emissions is lower than in the United States. Including such countries in an allowance-trading program would benefit both foreign firms (or governments) and U.S. firms.[12] Foreign companies would benefit from greater demand for their carbon allowances. U.S. companies would benefit from a greater supply of low-cost allowances. That greater supply would decrease the price of all allowances and let more U.S. firms buy allowances rather than reduce their emissions.

Analysts disagree about the viability of an international trading market for carbon allowances and the price at which foreign allowances would be available. This study assumes that the availability of cheaper foreign allowances would lower the worldwide price per allowance to \$60. That figure is arbitrary and reflects CBO's estimate of the price necessary to bring about a 10 percent cut in U.S. emissions; it does not reflect CBO's assessment of the potential viability of an international market for carbon allowances. (For a discussion of the major concerns associated with implementing such a market, see Box 2.)

If U.S. firms could purchase allowances (including foreign ones) for \$60 apiece, U.S. carbon emissions would fall by 10 percent from the baseline level (to 1.35 billion metric tons rather than 1.28 billion under domestic trading). Although some 70 million more allowances would be purchased under international trading, the price of an allowance would be sufficiently lower that total spending on allowances would fall from \$128 billion under domestic trading to \$81 billion under international trading (see Table 1). Substitution costs would also fall—from \$11 billion to about \$4 billion—because of the lower allowance price.

11. Providing each household with a lump-sum rebate would be similar to providing a fully refundable tax credit for the same amount.

12. A great deal of uncertainty exists about how a system of international trading would be implemented, including whether trading would take place among firms or governments.

Box 2.
Considerations About International Trading of Allowances

Allowance trading among governments or companies in different nations remains in the realm of theory, and analysts have raised numerous questions about how it would actually work. Examining the potential for active international trading in carbon allowances is beyond the scope of this study. But four of the major concerns about such trading are outlined below.

First, concerns about transaction costs (such as the costs of negotiating a trade and obtaining regulatory approval) are especially great with an international trading program. Coordinating the rules for approving trades among participating governments, establishing liability, and monitoring and enforcing trades would be essential to keeping transaction costs low. But resolving those issues for international carbon-allowance trading would be challenging. If high transaction costs discouraged international trading, the potential savings from such trading would not be realized.

Second, some analysts worry about the role of national governments in an international carbon-allowance market. In that view, "national governments might try to influence the market to their advantage, obstruct allowance trades, or otherwise depart from the conditions of well-functioning abatement markets assumed in the estimates of cost savings."[1] For example, governments could pursue strategies that favored domestic interests and that limited international trading.

1. Jonathan Baert Wiener, *Designing Markets for International Greenhouse Gas Control*, Climate Issue Brief No. 6 (Washington, D.C.: Resources for the Future, September 1997).

A third, related concern is the issue of market competition in an international allowance market. Some studies indicate that in an international trading market that included only industrialized countries, Russia would end up being the main seller of allowances. In that case, it might be able to influence the price of allowances, and it would have an incentive to veto the inclusion of other potentially large suppliers of allowances, such as China or Brazil.[2]

Fourth, in estimating how much a limit on carbon would cost the United States under international trading, analysts typically assume that international trading would minimize the cost of meeting the overall carbon limit agreed to by all participating countries. But for that to occur, all countries would need to use tradable-allowance systems to meet their national targets and allow for international trades—which might not actually be the case. The Kyoto Protocol, for example, allows countries to choose how they will meet their emission targets. Some countries have a history of using taxes to achieve environmental goals; other countries, which have less experience with market-based incentives, might mandate specific reductions for each source of emissions. To the extent that countries chose approaches other than allowance trading, the potential to minimize global costs would be reduced.[3]

2. Ibid.

3. See Robert W. Hahn and Robert N. Stavins, "What Has Kyoto Wrought? The Real Architecture of International Tradable Permit Markets" (draft working paper, John F. Kennedy School of Government, Harvard University, February 25, 1999).

Under international trading, the level of U.S. carbon emissions would exceed the amount of allowances issued by the U.S. government. Thus, total U.S. spending on allowances would exceed the value of the allowances allocated to U.S. firms. That fact has important implications for the distribution of the costs of a trading program among U.S. households—the subject of the next chapter.

Chapter Three

Distributing the Overall Economic Effects Among U.S. Households

A carbon trading policy would initially affect companies, but the results would ultimately affect households. This analysis distributes the overall economic effects described in the previous chapter among households in different income quintiles (categories that each contain one-fifth of U.S. households, ranked by income). That distribution depends mainly on the design of the trading policy, particularly on how the carbon allowances are allocated and how the government uses (or "recycles") the resulting revenue.

Data and Methods

Estimating the specific effects of a carbon trading program for each income quintile requires having detailed data on industries and households. The sample of households used in this study reflects the families and demographic mix found in the Census Bureau's Current Population Survey (CPS) for calendar year 1994. More detailed information on income and taxes from the Internal Revenue Service's Statistics of Income (SOI) database was merged with the CPS. The 1994 data were increased to reflect projected totals for 1998, so the analysis simulates the effects of carbon-allowance trading on a 1998 economy. Data on household consumption from the Bureau of Labor Statistics' Consumer Expenditure Survey (CEX) were merged with the household sample defined by the CPS.

Distributing Policy Costs

The share of substitution costs and allowance costs that any individual household would bear is determined by its consumption patterns. Households that consumed more carbon before the limit on emissions and the trading program took effect—for example, those that drove a lot—would bear a larger share of the policy's costs.[1]

Ratios of consumption to income play an important role in determining how large a burden the policy would impose on households in different quintiles. Households with high consumption-to-income ratios would tend to bear a higher cost (relative to their income) than households with low consumption-to-income ratios would. However, shortcomings in the available data on consumption and income make it difficult to precisely measure how large the policy costs would be relative to income. The CEX provides the best information about what households buy, but associated data on income appear to understate the resources available to some households. That understatement is particularly important at the bottom end

1. The Congressional Budget Office does not have quintile-specific estimates of policy-induced changes in carbon consumption. However, the assumption that high-carbon-consuming households will bear costs in the form of either higher prices (for continuing their carbon consumption) or substitution costs (for decreasing their carbon consumption) seems reasonable. Therefore, both allowance costs and substitution costs are distributed among households on the basis of their prepolicy consumption of carbon.

Table 3.
Households' Patterns of Consumption, by Income Group, 1998

Income Quintile	Total Consumption as a Percentage of After-Tax Income[a]: Based on Expenditure Data	Total Consumption as a Percentage of After-Tax Income[a]: Based on Net-Worth Data	Carbon-Intensive Consumption as a Percentage of Total Consumption[b]
Lowest	235.1	116.9	8.4
Second	144.3	113.4	7.4
Middle	121.3	110.4	6.8
Fourth	105.4	104.6	6.3
Highest	70.5	93.7	5.5

SOURCE: Congressional Budget Office calculations based on data from the Census Bureau's Current Population Survey, the Internal Revenue Service's Statistics of Income database, the Bureau of Labor Statistics' Consumer Expenditure Survey, and John Sabelhaus, "What Is the Distributional Pattern of Taxing Consumption?" *National Tax Journal*, vol. 46, no. 3 (September 1993), pp. 331-343.

NOTE: CBO defines a household according to the Census Bureau's definitions of a family, with some modifications. For example, unrelated individuals are included as separate households. When imputing consumption data to households, however, some unrelated individuals living together are grouped into households.

a. After-tax income before the policy change.

b. Carbon-intensive consumption includes spending on electricity, natural gas, fuel oil, coal, gasoline, and oil.

of the income distribution, where unreported income and private transfers (such as gifts from family members) may compose a larger share of household resources.[2] A consequence of that understatement is that consumption may look too large relative to reported income. For example, the CEX data suggest that households in the lowest income quintile spend more than twice their after-tax income (see Table 3). But recent research indicates that the consumption-to-income ratios implied by the CEX data may not be reasonable.[3]

An alternative to measuring consumption directly from the expenditure data in the CEX is to measure it indirectly from data on net worth that can be used to suggest saving rates and, in turn, consumption rates.[4] That approach yields more reasonable consumption-to-income ratios (see Table 3). For example, the net-worth-based approach implies that the average household in the lowest quintile consumed 17 percent more than its income in 1998, as opposed to the 135 percent more implied by the expenditure approach. However, the net-worth-based approach does not indicate why the consumption-to-income ratios obtained from reported data are so high for low-income households. It is unclear whether income is biased downward or consumption is biased upward, although the former seems more likely.

This study attempts to draw on the strengths of both approaches. Given that the CEX is designed to elicit reliable information about households' spending, the Congressional Budget Office uses that data to de-

2. Cash transfer payments from the government, such as Social Security and Supplemental Security Income payments, are included in the measure of income used in this study. In-kind transfers, such as Medicaid and Medicare benefits, are not included in the measures of income or consumption. As a result, government transfers do not account for the consumption-to-income ratios derived from expenditure data.

3. Low-income households may consume more than their annual income if their "permanent," or long-term, income is greater than their annual income. For example, a medical school student might borrow money to finance current consumption knowing that his or her future income would be much higher than current income. Recent research, however, indicates that the consumption-to-income ratios implied by the CEX data are more skewed than the difference between annual and permanent measures of income can explain. See John Sabelhaus and Jeffrey A. Groen, "Can Permanent-Income Theory Explain Cross-Section Consumption Patterns?" *Review of Economics and Statistics* (forthcoming).

4. See John Sabelhaus, "What Is the Distributional Pattern of Taxing Consumption?" *National Tax Journal*, vol. 46, no. 3 (September 1993), pp. 331-343.

termine quintile-specific consumption levels. It then uses the consumption-to-income ratios implied by the net-worth-based approach to increase income estimates to be consistent with those consumption estimates. That adjustment is not made for the top income quintile, where understated income is less of a problem.[5]

The pattern of consumption-to-income ratios resulting from the net-worth-based approach suggests that the costs of a carbon trading policy would be regressive—that is, they would fall more heavily on households toward the lower end of the income distribution. That would occur because low-income households consume a larger share of their income than their higher-income counterparts do. The degree of regressivity would be greater if CBO used the consumption-to-income ratios that result from expenditure data rather than those from net-worth data.

Income groups differ in the mix of consumer goods they purchase as well as in how much of their income they consume. Carbon-intensive consumption —defined here as spending on electricity, natural gas, fuel oil, coal, gasoline, and oil—makes up a larger fraction of the total spending of lower-income households (see Table 3). That pattern means that lower-income households would tend to bear a larger share of policy costs—relative to their total consumption—than higher-income households would.

Regardless of shortcomings in the available data, the general distributional pattern (or incidence) of the costs of a carbon trading policy is clear. The substitution costs and allowance costs associated with the policy would almost certainly be regressive (since low-income households spend more of their income than higher-income households do and also spend more of it on carbon-intensive goods). Differences between the actual pattern of quintiles' consumption-to-income ratios and the pattern used in this study (based on net-worth data) could mean that the actual policy costs would be more or less regressive than this analysis suggests. However, the general conclusion that the policy costs would be regressive is likely to be sound.

5. Such an adjustment would reduce income for the highest quintile, which would exacerbate any potential underreporting.

Distributing Allowance Value

Households would ultimately receive the value of the allowances that were distributed in a carbon trading program. Under the various allowance-allocation and revenue-recycling scenarios considered in this study, households would receive that value in one of three ways:

- By owning stock in firms that were given allowances,
- By receiving a lump-sum rebate, or
- By having their share of the corporate tax burden reduced.[6]

If the government gave allowances away, 55 percent of their value would eventually flow to households that own stock in the firms that received them. The government could distribute the allowances to upstream producers and importers of fossil fuels or to downstream users of fossil fuels (such as utilities, industrial boilers, airlines, trucking companies, and so on). Given the uncertainty about which firms the government would issue allowances to, CBO distributed the allowances' value among all stockholders on the basis of their observed dividend income and taxable capital gains income (as reported in the SOI). In other words, the distribution of dividend and capital gains income was used as a proxy for the distribution of stock ownership. The distributional effects associated with a specific allocation would differ from the distributional effects in this analysis if the income of shareholders in the firms that actually received the allowances differed from the income of shareholders in general. (For example, the allowance value would be more concentrated in higher income brackets than this study estimates if the government chose to give the allowances to upstream producers and importers and if

6. The tax return data in the SOI allow corporate taxes to be translated into household effects because those data contain detailed information about different pieces of income that are related to the ultimate incidence of various business-level taxes. CBO assigned corporate tax liabilities to households according to their personal capital income, based on an extensive literature on corporate tax incidence; see Congressional Budget Office, *The Incidence of the Corporate Income Tax*, CBO Paper (March 1996). The corporate tax initially falls on corporate capital, but when capital used by corporations flows into the economy, part of that tax burden is shifted onto capital in general in the form of reduced rates of return.

the shareholders of those firms were wealthier than shareholders in general.)

The government would capture 45 percent of the allowances' value if it gave the allowances away and all of that value if it distributed the allowances through an auction.[7] If the government used its share of the allowances' value to provide a lump-sum rebate, that value would be distributed equally among all households. If the government used its share of the allowances' value to reduce collections of corporate taxes, that value would be distributed among households according to their prepolicy share of the corporate tax burden.

Results of the Analysis

This analysis measures the effects of a carbon trading policy by the change in real (inflation-adjusted) annual cash income that the average household in each quintile would experience.[8] An increase in households' costs because of the policy is viewed as a decrease in real after-tax income. Because the results presented here are averages, the results for any particular household or geographic region could be different.

The distributional effects of carbon-allowance trading would vary depending on what allowance-allocation and revenue-recycling methods the government chose and on whether allowance trading was domestic or international. Because of the shortcomings in the available data on consumption and income, the distributional results that follow must be viewed as illustrative. Nonetheless, they provide a reasonable picture of how different policy designs would affect households across the income distribution. In particular, the general pattern of incidence and the relative ranking of the scenarios according to their regressivity are likely to hold true regardless of the actual dollar figures.

Results Under Domestic Trading

The total effect of a carbon trading policy on various households is the combined effect of the distribution of the policy costs and the distribution of the allowance value. The share of total policy costs that a household will bear because of changes in prices of fossil fuels and other goods is determined by its consumption patterns. The share of total allowance value that a household will receive is determined by the government's allowance-allocation and revenue-recycling methods.

Distributional Effects. The price changes that would result from a 15 percent cut in carbon emissions would cost the average household in the lowest income quintile $560 a year, or 3.3 percent of its average income (see Table 4). That policy cost includes both allowance and substitution costs. Although households in other quintiles would face higher costs in dollar amounts, those costs would make up a smaller share of their average annual income—1.7 percent in the case of the highest quintile. Thus, the policy costs are regressive. (Average policy costs as a share of income were reduced by the additional Supplemental Security Income and Social Security payments that households would receive when the price level rose. Such payments make up a relatively large share of household income in the lower quintiles, making the policy less regressive than it would appear if those payments were not adjusted.)

For all households, on average, allowance costs would amount to $1,210 per year. As noted earlier, that figure represents a transfer of income within the economy (from households that pay more in additional costs than they receive of the allowances' value to households where the opposite is true). Substitution costs represent the true average household costs of the carbon-allowance policy, which must be weighed against the benefits of a decrease in carbon emissions. Those costs would average $100 per year for all households, CBO estimates. Comparing the size of the average household's allowance and substitution costs shows how much is at stake in the government's

7. CBO assumes that the auction would extract the full value of the allowances. If that was not the case, the firms involved in the auction would receive some of the allowance value for free. The distributional effects associated with that share of the allowance value would be the same as if the government gave the allowances to firms.

8. Cash income excludes in-kind transfers and accrued but still unrealized income. CBO could have presented results based on an alternative measure of income, adjusted family income, which adjusts for family size. Using that measure would alter the quantitative results slightly, but it would not affect the conclusions of this analysis in any qualitative way.

decision about how to allocate allowances: the amount of wealth transferred by the allocation process would dwarf the substitution costs of the policy (as the overall figures in Chapter 2 also demonstrated).

Of the four allowance-allocation and revenue-recycling scenarios that CBO analyzed, the share of policy costs borne by households in the lowest income quintile would be largest if the government gave allowances away and used the revenue that it received (from taxes on the increased profits) to reduce corporate taxes. In that case, average household income for the lowest quintile would fall by $530, or 3.1 percent (see Table 5). Households in the highest income quintile, by contrast, would see their average income rise by $1,810, or 1.8 percent. That increase would occur because those households' gains from the share of allowance value that they received directly (through their stock holdings) and indirectly (as the decrease in corporate income taxes boosted the rate of return on their capital) would exceed their cost increases because of the policy. The estimated rise in income for the average household in the highest quintile—and the drop in income for the average household in the lowest quintile—would be larger under this scenario than under any of the other three that CBO examined, making this the most regressive of the scenarios.

At the other end of the spectrum, the share of policy costs borne by households in the highest income quintile would be greatest if allowances were auctioned off and the revenue used to provide lump-sum rebates to all households. In that scenario, households in the top quintile would experience a $940, or 0.9 percent, decline in average real income, while those in the lowest quintile would see their average income rise by $310, or 1.8 percent. Average household income in the lowest quintile would increase because those households' lump-sum rebates would be larger than their cost increases as a result of the policy. Thus, CBO estimates, a carbon trading policy would have a progressive distributional effect if the government sold the allowances through an auction and divided the revenue equally among households.

A third scenario in CBO's analysis, an auction of allowances followed by a cut in corporate taxes, would be slightly less regressive than the most regressive scenario, free distribution and a corporate tax cut. If the government auctioned off the allowances and used the revenue to decrease corporate taxes, the full value of the allowances would benefit households that own all of the various forms of capital, including interest and rental income as well as stock-related income (because all households with capital income are as-

Table 4.
Increase in Average Household Costs Because of Allowance Costs and Substitution Costs

	Average for Income Quintile					Average for All Households[a]	
	Lowest	Second	Middle	Fourth	Highest	Allowance Costs	Substitution Costs
Cost Increase							
In dollars	560	730	960	1,240	1,800	1,210	100
As a percentage of income[b]	3.3	2.9	2.8	2.7	1.7	2.7	0.2

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table derive from data on each quintile's cash consumption and estimates of cash income. More complete measures of income and consumption would include in-kind items, such as employer-paid health benefits or food stamps, and thus could yield somewhat different findings. Data limitations preclude such measures, however. Consequently, those numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as exact figures.

a. Includes the government's share of allowance and substitution costs. (The distribution of that share among households depends on the government's specific allowance-allocation and revenue-recycling strategies, so government costs are not included in the average costs for each quintile.)

b. The cost increases are equivalent to percentage decreases in after-tax income.

sumed to benefit from a decrease in corporate taxes). If the government gave the allowances away, in contrast, only 45 percent of the allowance value would benefit all capital owners (the share that the government captured through taxes and used to decrease corporate taxes). The other 55 percent would benefit only those capital owners who held stock in firms that received the allowances. Because stocks are more concentrated in higher-income households than capital as a whole is, a policy that directed more benefits to stockholders would be more regressive. Morever, the allowance value that would flow to households through increases in stock value under a free distribution would be concentrated in the relatively few households within each quintile that owned stock in the companies that received allowances (a difference that is not apparent from the results presented in this study). In contrast, the gains associated with decreasing corporate taxes would be much more widely distributed among households within each quintile.

Table 5.
Change in Average After-Tax Household Income Under Various Allowance-Allocation and Revenue-Recycling Scenarios, with Domestic Trading Only

Allowance-Allocation/ Revenue-Recycling Scenario	Average for Income Quintile: Lowest	Second	Middle	Fourth	Highest	Average for All Households: Excess Allowance Costs[a]	Substitution Costs	Potential for Efficiency Gains
Free Distribution/Decrease in Corporate Taxes								
In dollars	-530	-600	-740	-900	1,810	0	-100	Some
As a percentage of income[b]	-3.1	-2.4	-2.2	-1.9	1.8	0	-0.2	
Auction/Decrease in Corporate Taxes								
In dollars	-510	-530	-630	-790	1,510	0	-100	Greatest
As a percentage of income[b]	-3.0	-2.1	-1.9	-1.7	1.5	0	-0.2	
Free Distribution/Lump-Sum Rebate								
In dollars	-340	-450	-620	-800	1,250	0	-100	None
As a percentage of income[b]	-2.0	-1.8	-1.8	-1.7	1.2	0	-0.2	
Auction/Lump-Sum Rebate								
In dollars	310	140	-90	-370	-940	0	-100	None
As a percentage of income[b]	1.8	0.5	-0.3	-0.8	-0.9	0	-0.2	

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table derive from data on each quintile's cash consumption and estimates of cash income. More complete measures of income and consumption would include in-kind items, such as employer-paid health benefits or food stamps, and thus could yield somewhat different findings. Data limitations preclude such measures, however. Consequently, these numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as exact figures.

a. Allowance cost borne by the average U.S. household minus allowance value received by the average U.S. household.

b. Measured as a percentage of after-tax income before the policy change.

The final scenario, free distribution of allowances coupled with a lump-sum rebate of government revenue, would be less regressive than the scenario above (an auction and a decrease in corporate taxes). In this case, average household income in the highest quintile would rise by 1.2 percent. The share of allowance value captured by shareholders under a free distribution of allowances would be more concentrated in higher-income households than the benefits of a corporate tax cut would be. But the government could use its share of the allowance value from a free distribution to offset policy costs for low-income households, thus reducing the regressivity of that method of allocation (assuming that the government recognized that tax collections would rise as a result of the recipient firms' windfall profits and recycled that additional revenue). The government would, however, have more funds available for helping low-income households if it auctioned off allowances than if it gave them away (see Box 3). The amount of revenue available for lump-sum rebates would more than offset policy costs for low-income households if the government auctioned off allowances, but not if it distributed them for free.

How do those distributional results compare with the effects of other allowance-allocation and revenue-recycling strategies? The distributional effect of recycling revenue is determined by the progressivity of the taxes that are cut. The personal income tax is less progressive in its incidence than the corporate income tax, so if revenue was used to reduce personal income taxes, the results would be less regressive than if revenue was used to lower corporate income taxes. (In other words, since lower-income households bear a larger share of the personal income tax burden, they would receive a larger share of the benefits if it was reduced.) Likewise, payroll taxes are less progressive than either corporate or personal income taxes. Thus, if the government used its additional revenue to cut payroll taxes, the policy would still be regressive but less so than if either personal or corporate income taxes were reduced.[9]

9. That discussion assumes that tax rates would be reduced proportionately. For example, if personal income tax collections were cut by 5 percent, CBO assumes that the rate for each tax bracket would be cut by 5 percent. However, progressive taxes could be reduced in a way that would give the reduction a progressive distributional effect. For example, rates for lower tax brackets could be cut more than rates for higher tax brackets.

Box 3.
Offsetting the Additional Costs to Low-Income Households

When the government sells emission allowances through an auction, it captures more of their value than when it gives the allowances away. That means the government has more funds available to offset the additional costs that the allowance policy imposes on low-income households, if it wants to.

One way to assess different methods for allocating allowances is to consider how many low-income households the government could compensate for policy-induced increases in their costs. Under the assumptions made in this analysis, if the government gave away carbon allowances and directed all of the value that it captured to low-income households, it could offset cost increases for all of the households in the lowest quintile and approximately 70 percent of the households in the second quintile. (That estimate assumes that households are compensated for their actual loss in real income as a result of the policy; that loss equals their share of allowance and substitution costs minus the income that they receive from the free distribution of allowances.)

Households above that cutoff, however, would not receive any of the government's share of the allowance value. Households in the second quintile that were not compensated would see their real income fall by 2.6 percent, and households in the middle and fourth quintiles would experience 2.4 percent and 2.2 percent declines, respectively. Households in the highest income quintile would be better off than before because they would capture the majority of the allowance value through owning stock in the companies that received the allowances. Their average household income would rise by $1,000, or 1 percent. Thus, although this approach would offset cost increases for some low-income households, it would be regressive for households above the cutoff.

The government could offset cost increases for more households if it auctioned off allowances, because it would capture all of their value. In that case, the government could compensate all of the households in the first four quintiles and approximately 45 percent of the households in the highest quintile for their policy-induced costs. Households in the highest quintile that did not receive compensation would see their income decline by an average of $1,800, or 1.7 percent.

Table 6.
Change in Average After-Tax Household Income Under Various Allowance-Allocation and Revenue-Recycling Scenarios, with International Trading

Allowance-Allocation/ Revenue-Recycling Scenario	Average for Income Quintile: Lowest	Second	Middle	Fourth	Highest	Average for All Households: Excess Allowance Costs[a]	Substitution Costs
Free Distribution/ Decrease in Corporate Taxes							
In dollars	-330	-370	-460	-550	1,070	-40	-40
As a percentage of income[b]	-1.9	-1.5	-1.4	-1.2	1.0	-0.1	-0.1
Auction/Decrease in Corporate Taxes							
In dollars	-320	-330	-390	-490	890	-40	-40
As a percentage of income[b]	-1.9	-1.3	-1.1	-1.1	0.9	-0.1	-0.1
Free Distribution/ Lump-Sum Rebate							
In dollars	-210	-280	-380	-500	730	-40	-40
As a percentage of income[b]	-1.2	-1.1	-1.1	-1.1	0.7	-0.1	-0.1
Auction/Lump-Sum Rebate							
In dollars	180	70	-70	-240	-590	-40	-40
As a percentage of income[b]	1.1	0.3	-0.2	-0.5	-0.6	-0.1	-0.1

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table derive from data on each quintile's cash consumption and estimates of cash income. More complete measures of income and consumption would include in-kind items, such as employer-paid health benefits or food stamps, and thus could yield somewhat different findings. Data limitations preclude such measures, however. Consequently, these numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as exact figures.

a. Allowance cost borne by the average U.S. household minus allowance value received by the average U.S. household.

b. Measured as a percentage of after-tax income before the policy change.

Implications for Economic Efficiency. Although this study focuses on the distributional effects of several possible allowance-allocation and revenue-recycling strategies, different strategies would also have different implications for economic efficiency. Quantifying those efficiency trade-offs is beyond the scope of this analysis, but some general conclusions are possible.

The government could use its increased revenue to stimulate economic activity and thus reduce the economic cost of achieving a 15 percent reduction in carbon emissions. That could occur if it used the revenue to offset existing taxes—such as those on capital, labor, and personal income—that discourage economic activity by discouraging labor and investment. If those taxes were reduced, incentives to save, invest, or work could increase, and efficiency gains could result.[10] If, instead, the government opted to recycle revenue in the form of a lump-sum rebate, it would not increase the incentives for work and investment, and no efficiency gains would be realized (see Table 5). In addition, the fraction of allowance value that shareholders would receive if the government gave allowances away would not provide those households with increased incentives for work and investment.

10. Those efficiency gains are measured relative to a policy that restricts carbon emissions but does not reduce existing taxes.

Table 7.
Change in Average After-Tax Household Income When Domestic Trading Is Replaced by International Trading

Allowance-Allocation/ Revenue-Recycling Scenario	Average for Income Quintile: Lowest	Second	Middle	Fourth	Highest	Average for All Households: Excess Allowance Costs[a]	Substitution Costs
Free Distribution/ Decrease in Corporate Taxes							
In dollars	200	230	280	350	-740	-40	60
As a percentage of income[b]	1.2	0.9	0.8	0.7	-0.7	-0.1	0.1
Auction/Decrease in Corporate Taxes							
In dollars	190	200	240	300	-620	-40	60
As a percentage of income[b]	1.1	0.8	0.7	0.6	-0.6	-0.1	0.1
Free Distribution/ Lump-Sum Rebate							
In dollars	130	170	240	300	-520	-40	60
As a percentage of income[b]	0.8	0.7	0.7	0.6	-0.5	-0.1	0.1
Auction/Lump-Sum Rebate							
In dollars	-130	-70	20	130	350	-40	60
As a percentage of income[b]	-0.7	-0.2	0.1	0.3	0.3	-0.1	0.1

SOURCE: Congressional Budget Office.

NOTE: The numbers in this table derive from data on each quintile's cash consumption and estimates of cash income. More complete measures of income and consumption would include in-kind items, such as employer-paid health benefits or food stamps, and thus could yield somewhat different findings. Data limitations preclude such measures, however. Consequently, these numbers should be viewed as illustrative and broadly supportive of the conclusions in this analysis rather than as exact figures.

a. Allowance cost borne by the average U.S. household minus allowance value received by the average U.S. household.

b. Measured as a percentage of after-tax income before the policy change.

The potential for efficiency gains is greater if a cut in corporate income taxes follows an allowance auction rather than a giveaway of allowances. The reason is that the amount of revenue for recycling is greater when allowances are auctioned off; hence, the decrease in corporate income taxes can be larger. That means that the auction and corporate tax cut strategy surpasses the free distribution and corporate tax cut strategy from the perspectives of both equity and economic efficiency (see Table 5).

Results Under International Trading

How would international trading alter the domestic trading results outlined above? Under domestic trading, the net effect (on average for all households) of companies passing their allowance costs on to households (through price increases) and of the government distributing allowance value to households would be zero. (That result is indicated by the zeros in the column labeled "excess allowance costs" in Table 5.) But under international trading, U.S. spending on allowances would exceed the value of U.S.-issued allowances by some $40 per household (see Table 6). That

Box 4.
How a General-Equilibrium Analysis Might Change the Distributional Effects

The distributional effects reported in this study result from a "partial-equilibrium" analysis, which focuses on how increases in the cost of carbon would affect households through changes in the prices of consumer goods. But a carbon-allowance policy could also place unequal burdens on households through changes in the prices and quantities of other markets, such as those for capital and labor. In other words, "general-equilibrium" effects might occur. Those effects could alter the distributional results reported here through two main channels: interactions with existing taxes and output effects on the relative returns to capital and labor.

Effects Through Existing Taxes

The economics literature on the efficiency effects of pollution taxes says that the presence of other taxes, and the distortions they cause, will affect the ultimate costs that new pollution-reducing requirements impose on society. Most economists have concluded that pollution-reducing requirements exacerbate the discouraging effect that existing taxes on labor and capital have on economic activity—a connection known as the tax-interaction effect.[1]

This study's estimate of the inefficiency, or substitution, cost of a carbon trading policy does not take into account existing taxes. Thus, it probably understates the cost of the policy to the economy as a whole. Measuring and distributing the additional losses from existing taxes, however, is not possible without using a computable-general-equilibrium (CGE) model. Such a model would specify behavioral choices for different types of households and allow a more complete estimate of how an increase in the cost of carbon would affect other markets. For example, higher consumer prices (caused by the allowance requirement) would lead to lower real wages and thus decrease the labor supply. That decrease would exacerbate the distortions in the labor market caused by taxes on labor. In addition, accounting for taxes in other markets would mean that the cost of a carbon-allowance program would be different with lump-sum rebates than with a cut in corporate taxes. That difference would occur because cutting corporate taxes would lower the inefficiencies that such taxes cause, but issuing lump-sum rebates would not.

Existing taxes also matter because they generate a prepolicy revenue base. According to information from CGE modelers who participated in Stanford University's Energy Modeling Forum, the 15 percent cut in carbon emissions assumed in this study could reduce gross domestic product (GDP) by about $22 billion. Such a drop would imply a decrease in government tax receipts equal to 40 percent of the decline in GDP, or roughly $8.8 billion, the Congressional Budget Office (CBO) estimates. Lower tax receipts would

1. For a good survey of this literature, see A. Lans Bovenberg and Lawrence H. Goulder, "Environmental Taxation," in Alan Auerbach and Martin Feldstein, eds., *Handbook of Public Economics*, 3rd ed. (Amsterdam: Elsevier, forthcoming).

excess allowance spending would be paid to foreign firms.

Taken in isolation, excess allowance costs would make the average U.S. household worse off under international trading than under domestic trading.[11] That is only part of the story, however. International trading would also lower substitution costs (from $100 per average household to $40). As a result, total costs —excess allowance costs plus substitution costs— would be $80 per household under international trading as opposed to $100 under domestic trading. Overall, therefore, international trading would make U.S. households better off because it would lower the total policy costs for the nation as a whole. That result holds true regardless of what assumptions are made about the price of foreign allowances or the speed at which carbon emissions decrease as allowance prices rise (the price-responsiveness estimate). The size of the gain, however, would vary depending on those assumptions.

Households that would bear a disproportionate share of the costs of a carbon trading program (rela-

11. The United States would need to export more of its goods to pay for the import of foreign allowances, which would crowd out domestic consumption.

Box 4.
Continued

reduce the revenue available for recycling and thus the government's ability to use revenue recycling to achieve goals of equity or efficiency.

CBO interprets the estimates of GDP loss from the Energy Modeling Forum participants as corresponding to a carbon trading program with lump-sum revenue recycling. The $8.8 billion decline in tax receipts would reduce each household's rebate by $80 (from a level of $860 if allowances were auctioned and $200 if they were distributed for free).

Recycling revenue by cutting corporate taxes would produce a smaller decline in GDP, and hence a smaller revenue loss, because it would reduce the overall inefficiency cost of the carbon-allowance policy. However, the basic finding that a carbon trading policy would be less regressive if the government recycled its additional revenue by issuing lump-sum rebates than if it decreased corporate taxes would remain the same. That result would hold true even under the extreme assumption that cutting corporate taxes would produce no decline in overall revenue.

Output Effects on Relative Returns

The second way that the general-equilibrium effects of a carbon-allowance policy could affect households differently is through changes in the relative returns to capital and labor. The pioneering work of economist Arnold Harberger showed that taxes on specific types of factors or output can affect the relative returns to factors of production, depending on "factor substitution" and "output effects."[2] In the context of this study, it is the output effects that are relevant: a charge on carbon can alter the relative returns to laborers versus capitalists, depending on how the ratio of capital to labor in carbon-intensive industries compares with the ratios in other industries. As production in carbon-intensive industries declines, production in other industries that use less carbon will increase, and that change in the mix of outputs implies changes in relative demands for capital and labor.

For example, if the carbon-intensive energy sector of the economy is more capital-intensive (has a higher capital-to-labor ratio) than other industries, the general-equilibrium output effects would cause the net rate of return on capital to fall relative to the net wage rate. Such effects on relative factor returns would affect the distribution of the cost or tax burden among income quintiles, because capital income is concentrated among higher-income households. Thus, if carbon production was capital-intensive, the general-equilibrium output effects on relative factor returns would tend to alleviate some of the regressivity associated with higher prices for consumer goods. But if carbon production was labor-intensive, any regressivity would be exacerbated.

2. See Arnold C. Harberger, "The Incidence of the Corporation Income Tax," in Harberger, ed., *Taxation and Welfare* (Boston: Little, Brown, 1974), pp. 135-162.

tive to their share of the allowance value) would see their situation improve under international trading compared with domestic trading. (That result is illustrated in Table 7 on page 25, which shows the relative gain or loss that households would incur if a foreign supply of allowances were available. In other words, it shows the difference between the changes in Table 6 and the changes in Table 5.) Households that would experience losses under domestic trading—low-income households in all of CBO's scenarios except an auction and lump-sum rebate—would be made better off by international trading. For example, in the free distribution and corporate tax cut scenario, the after-tax income of the average household in the lowest quintile would be $200 higher with international trading than with domestic trading alone.

Likewise, households that would receive a disproportionate share of the allowance value under domestic trading—high-income households in all of CBO's scenarios except the auction and lump-sum rebate—would be worse off under international trading. For example, in the free distribution and corporate tax cut scenario, international trading would reduce average household income in the highest quintile by $740.

Limitations of the Analysis

One drawback of CBO's study is that it takes a "partial-equilibrium" approach to analyzing the distributional effects of a carbon trading policy. In other words, it examines how the policy would affect households through changes in the prices of consumer goods, but it does not account for other possible effects of the policy, such as impacts on the markets for capital and labor. Accounting for those effects would require using a "general-equilibrium" approach (see Box 4 on pages 26 and 27).

By relying on detailed household-level data, this study can account for the overall reduction in carbon emissions that would occur and distribute total costs and allowance value among households on the basis of their existing patterns of consumption, income, and taxes. But using those data means focusing on annual measures of income and spending. Such an annual perspective may not accurately reflect a lifetime perspective, because ratios of consumption to income vary throughout people's lives. Other analyses, however, suggest that any policy that raises the price of consumer goods would continue to be regressive (although to a lesser degree) if it was based on lifetime spending relative to lifetime income. The reason is that lifetime consumption as a share of lifetime income—like the annually based ratio—tends to fall as the level of lifetime income rises (because bequests rise with income).[12] Further, information about lifetime incidence of a policy can be inferred from annual data by examining the subset of the population that is middle aged. CEX data indicate that consumption-to-income ratios would decline with increases in income for middle-aged households, but to a lesser extent than for the population as a whole.[13] That indicates that the price effects of a carbon trading policy would continue to be regressive, but slightly less so, if measured on a lifetime basis.

Another limitation of this analysis is that it is based on average national effects. For example, the estimate of how much the cost of electricity would increase reflects the average carbon intensity of electricity production throughout the United States. The actual cost of the policy would vary significantly between regions depending on the fuels used to generate electricity in each place. In addition, the effects experienced by any particular household could differ significantly from the effects on the average household in its quintile because of differences in individual households' patterns of consumption.

12. See Diane Lim Rogers and Don Fullerton, *Who Bears the Lifetime Tax Burden?* (Washington, D.C.: Brookings Institution, 1993); Paul L. Menchik and Martin David, "The Incidence of a Lifetime Consumption Tax," *National Tax Journal*, vol. 35, no. 2 (June 1982), pp. 189-203; and Gilbert E. Metcalf, "A Distributional Analysis of Green Tax Reforms," *National Tax Journal*, vol. 52, no. 4 (December 1999), pp. 655-681.

13. That pattern occurs because income is more equal across quintiles for middle-aged people than it is for the population as a whole.

Conclusions

CBO's analysis shows that the ultimate incidence of a carbon trading policy is largely a function of the policy's design. Although the distribution of allowance and substitution costs is determined by households' purchasing patterns, that is just part of the story. The government determines the ultimate incidence of the policy by choosing how to allocate emission allowances and how to use the increased revenue it collects as a result. Understanding the distributional implications of those choices is important because the amount of wealth that a carbon trading policy would redistribute could be very large, dwarfing the magnitude of the substitution costs.

The government could use its share of the allowances' value to achieve at least two possible goals: making the policy more equitable by recycling the revenue in a way that offset the regressivity of the policy-induced price increases, or seeking gains in economic efficiency by using the revenue to decrease existing distortionary taxes. The government's ability to achieve either of those goals would be greater if it auctioned off allowances than if it gave them away.

Furthermore, the goals of equity and efficiency could conflict. A strategy that sought efficiency gains by cutting corporate income taxes would make the policy even more regressive than its initial price ef-

fects.[14] Such a cut would be both more equitable and more efficient if it followed an auction of allowances rather than a giveaway. Nevertheless, both of those scenarios would be regressive overall; the free distribution and corporate tax cut would simply be more regressive. The share of allowance value that is captured by households when the government gives allowances away (as it has done with past pollution-rights trading programs) increases the regressivity of the policy and does not generate any increased saving or investment. The only one of the four policy scenarios in CBO's analysis that was not regressive was an allowance auction followed by a lump-sum rebate of the resulting revenue.

This study did not look at using more than one allowance-allocation or revenue-recycling strategy at once. But in reality, the government could use its revenue to meet several objectives simultaneously. For example, it could use some of the revenue to offset the effects of price increases on low-income households and some to improve economic efficiency by paying down the national debt or reducing existing taxes. Likewise, some of the allowances could be distributed for free while the remainder were sold at auction. Some researchers have examined what fraction of the revenue from a carbon-allowance auction would be necessary to compensate firms in the fossil-fuel sector for their transitional (or adjustment) costs. Those analysts assume that the rest of the revenue would be used to offset existing taxes.[15] Likewise, proposals by Resources for the Future and the Corporation for Enterprise Development would use auction revenues in a combination of ways.

Finally, this analysis concludes that international trading of carbon allowances would lower the total cost imposed on U.S. households, but that gain would not be shared equally. Households that would receive a disproportionate share of the allowances' value in a given allowance-allocation and revenue-recycling scenario under domestic trading would be relatively worse off under international trading, because the total value associated with U.S.-issued allowances would fall as the supply of foreign allowances lowered the price per allowance. But households that would experience a loss in real income under domestic trading would be relatively better off under international trading. In all but one of the allowance-allocation and revenue-recycling scenarios that CBO examined, lower-income households would fare better under international trading than domestic trading and households in the highest income quintile would fare worse.

14. That would be true for proportional decreases in any progressive tax, including personal income taxes and payroll taxes.

15. See A. Lans Bovenberg and Lawrence H. Goulder, "Neutralizing the Adverse Industry Impacts of CO_2 Abatement Policies: What Does It Cost?" (paper prepared for the Fondazione Eni Enrico Mattei and National Bureau of Economic Research Conference on Behavioral and Distributional Effects of Environmental Policy, Milan, Italy, June 1999).